

Wildland Fire and CO₂ Emissions

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The regional and global carbon cycles have emerged as an important field in ecosystem research in the past two decades because of their role in the greenhouse effect and possible global warming. Wildland fire, including uncontrolled wildfire and prescribed burning, is one of the critical processes in the regional and global carbon cycle. Emissions from wildland fire directly affect the carbon cycle by increasing atmospheric CO₂. Major fires can have a dramatic impact; for example, the 1997 Indonesian fires emitted as much carbon into the atmosphere as all the living things on the planet remove from it in a year, which about equals the annual carbon emissions from burning fossil fuel in Europe. Wildland fire also affects the carbon cycle in less direct fashion, by altering the uptake of carbon by terrestrial ecosystems. Biomass accumulates by consuming atmospheric carbon through photosynthesis. Terrestrial ecosystems thus are sinks for carbon and fire disturbance alters the magnitude of the sink.

We've looked at wildland fire and CO₂ emissions, trying to understand the role of wildland fire in the carbon cycle over the U.S. Unfortunately, the data needed to examine all wildland fires simply are not available and the quality of the existing data seriously underestimate the amount of wildland fire in the South. Nevertheless, we used available fire and meteorological datasets to provide at least an idea of the current emissions and potential effects of climate change. The available datasets included historical U.S. wildfires on public land during 1980-2002 (obtained from the USDA Forest Service and other federal agencies) and temperature and precipitation in each of the contiguous U.S. states (obtained from NOAA). Because of the truncated data on fire (only wildfires on public land; no data for prescribed burning or wildfires on private land), these results provide an incomplete picture. Fire emissions of CO₂ were estimated from area burned, effective fuel consumption, and emission factors. The potential impact of the greenhouse effect on wildfire CO₂ emission on public land was analyzed based on climate change projected by the Hadley Center's Second Generation Coupled Ocean-Atmosphere GCM (HadCM2).

We found that current wildfires on public land release over 10 tons km⁻² of CO₂ annually in the West and Southeast (Fig.1). The emissions vary remarkably from one year to another with large amounts found in 1988, 1996, 2000, and 2002. The region-integrated annual emissions are significant in the Inter-Mountain, Pacific South, Pacific North, and Southeast regions. Emissions are dominant in summer in the West except the Southwest region, where emissions in spring are also important. Springtime emissions are also important in the East. Summer emissions account for about 80% of annual amount nationwide. The HadCM2 model projects an increase in summer temperature by 1~1.5°C and an increase in summer rainfall by up to 8 mm in most U.S. regions by 2050 due to

the greenhouse effect. The change in temperature would increase CO₂ emissions of wildfire on public lands and the increased rainfall would decrease the emissions, but overall the change in temperature plays the more important role. The projected climate change would lead to a relative increase of emissions by nearly 150% in the Southwest and 100% in the North (Fig.2). Nationally, the relative increase is about 50%.

This study suggests a substantial increase in future U.S. wildfire activities on public land due to the projected climate change induced by the greenhouse effect. The contribution of the wildfire emissions to atmospheric CO₂ concentration accordingly would become more important. A further caveat is the model does not take into account potential vegetation type changes in response to climate change.

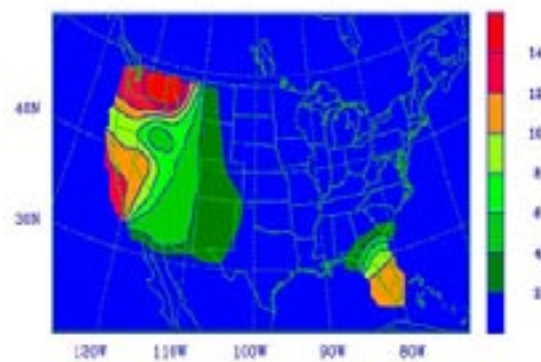


Fig.1 Annual CO₂ emissions from wildfires on public land (ton km⁻²).

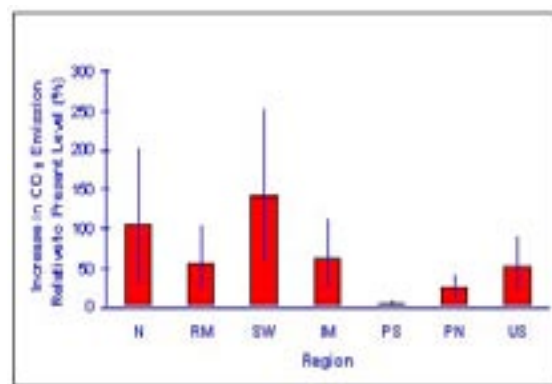


Fig. 2 Relative regional increases by 2050 over the current level of summer CO₂ emissions from wildfires on public lands due to climate change induced by the greenhouse effect. The columns and vertical lines represent the averages and uncertainty ranges, respectively.